Instructions for the Wimberley Toolholder

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SAFETY

Some of the tools shown in these instructions are intrinsically dangerous and can cause serious injury or death. Always exercise appropriate caution for your safety and the safety of those around you when using power equipment. For the purposes of these instructions some OSHA-approved guards may have been removed.

I am not a professional machinist, and the purpose of these instructions is to educate the viewer about the use of the Wimberley toolholder and how to sharpen the bit for the toolholder. These instructions are not intended as a tutorial in machine shop or other shop practice.

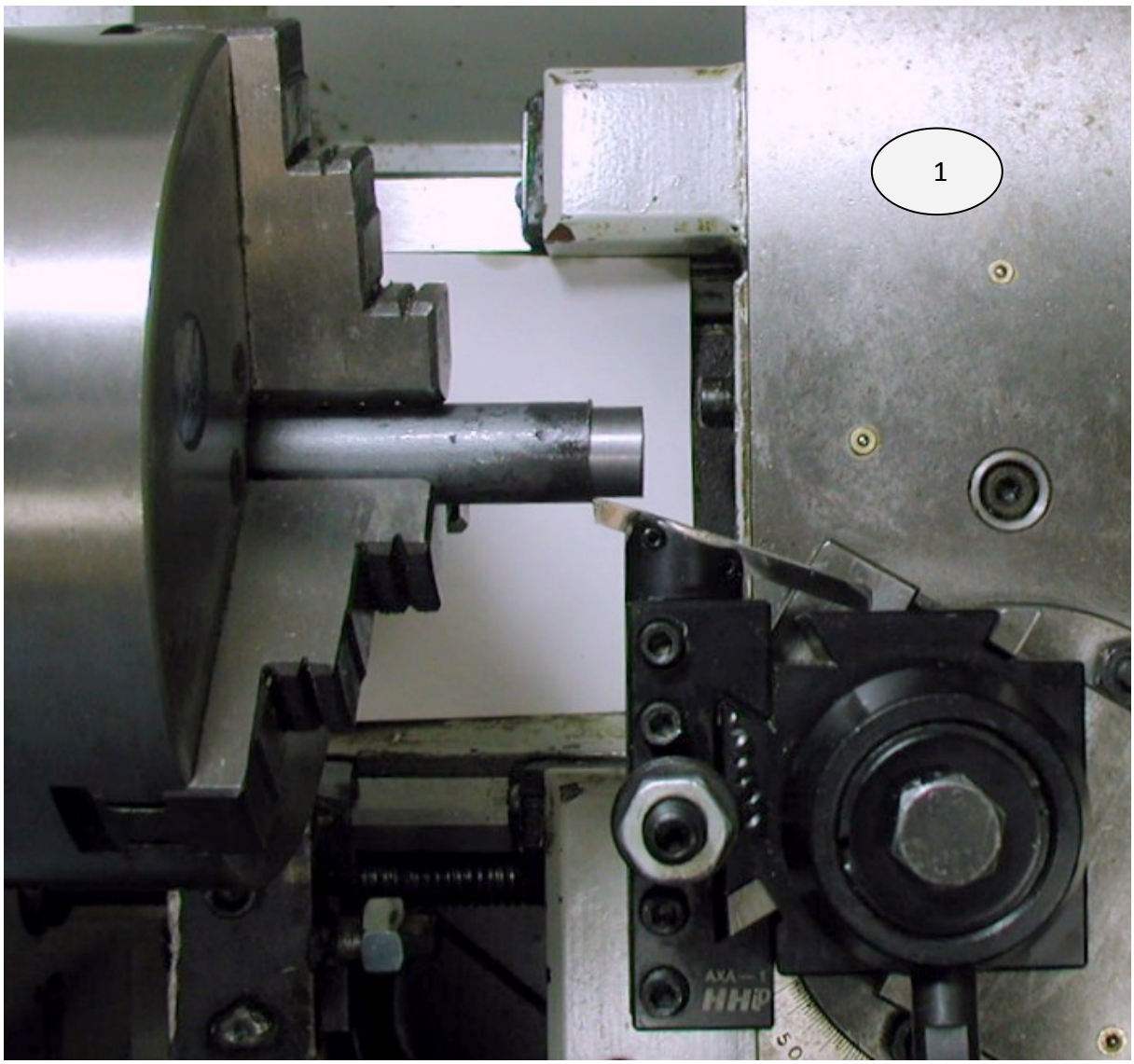
Please make use of any instruction manuals that come with your machine tools and other power tools. There are many books and videos as well as other forms of instruction available for those who want to learn how to use machine tools and other shop tools.

PATENT

A patent has been applied for. The patent application number is 20100272521

THE TOOLHOLDER IN PLACE IN THE LATHE

Photographs 1, 2, and 3, show the toolholder in use. Photographs 1 and 2 show a Tool bit with negative lead angles whereas photograph 3 shows a Tool bit with positive lead angles.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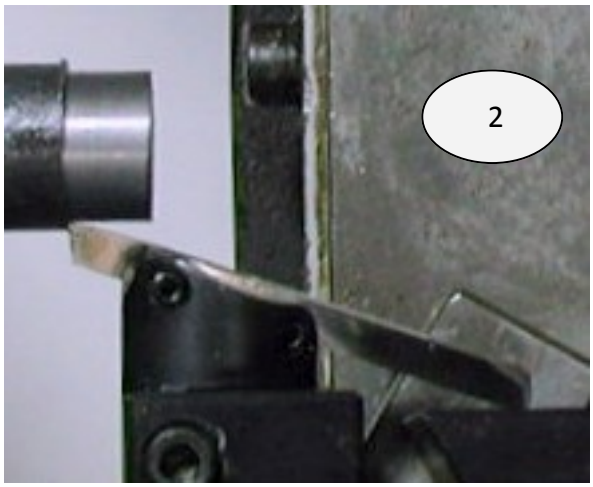
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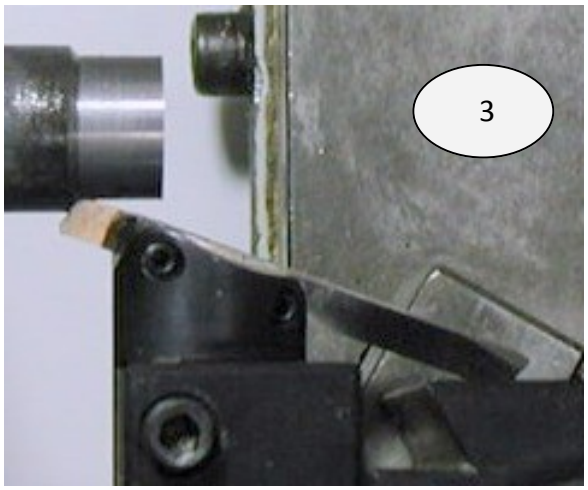
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NOMENCLATURE

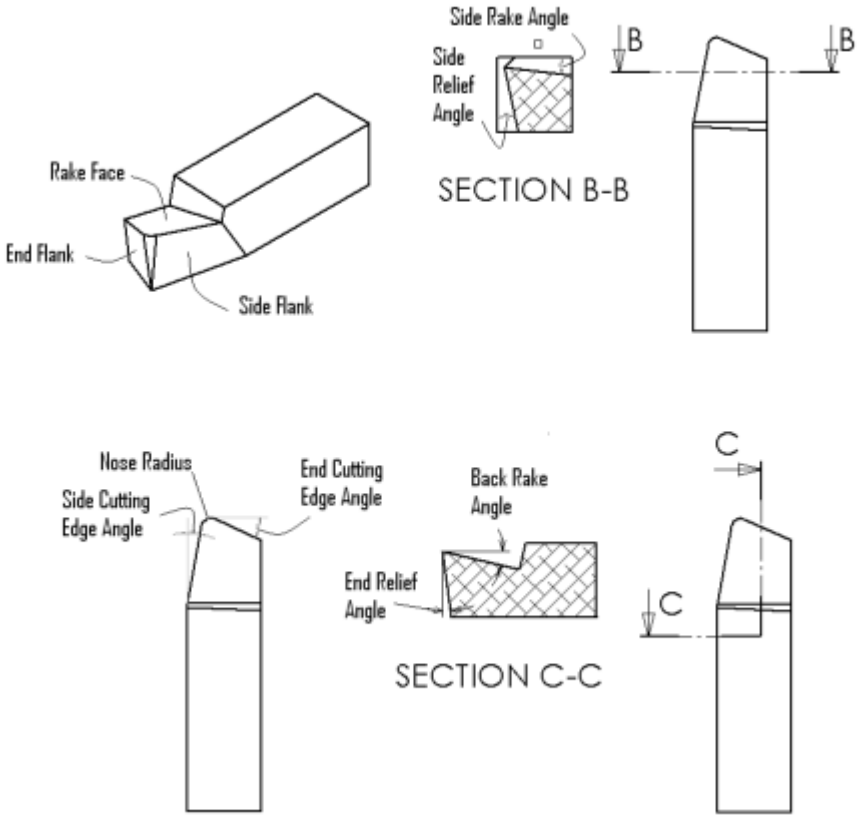


Figure 1

Figure 1 depicts the classic high speed steel lathe tool bit. This figure is included to explain the various angles of the bit. The axis of this tool is horizontal and perpendicular to the axis of the lathe. This tool is designed to cut from right to left.

Because the above tool bit is perpendicular to the Rotational axis of the lathe, the cutting edge angles are the same as the lead angles. (The side-cutting **lead** angle is measured from a plane is perpendicular to the axis of the lathe. Because the tool bit in the Wimberley Toolholder will not be presented perpendicular to the axis of the lathe, I will henceforth refer to lead angles rather than cutting edge angles.)

The end cutting lead angle can also be considered a clearance angle because this tool is used only for turning and that angle is there to provide clearance.

GEOMETRY OF THE TOOLHOLDER

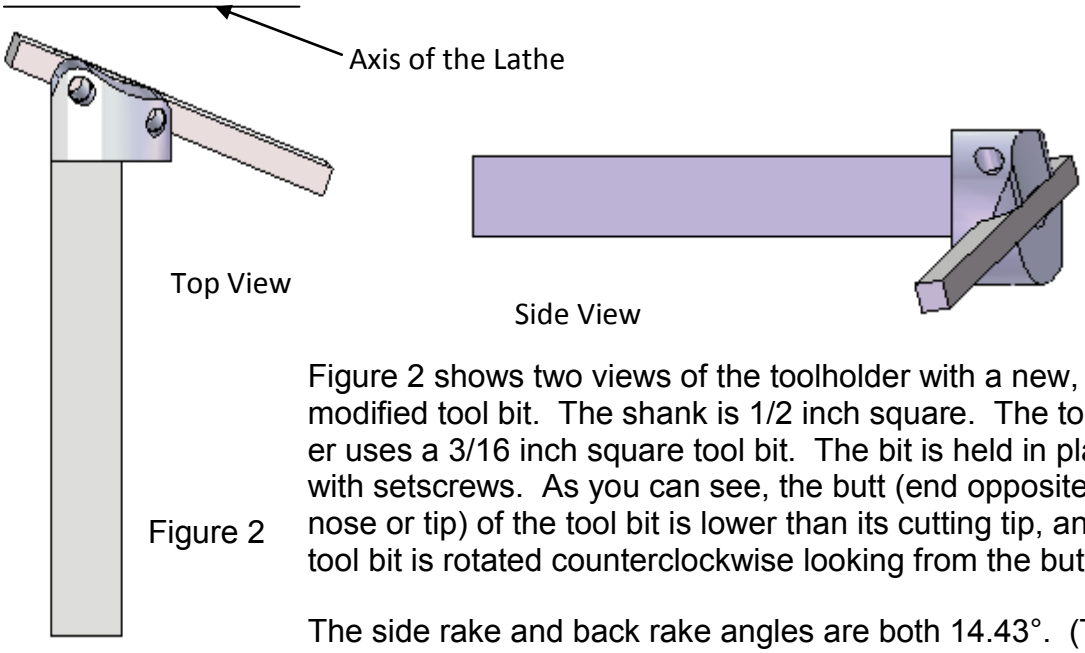


Figure 2

Figure 2 shows two views of the toolholder with a new, unmodified tool bit. The shank is 1/2 inch square. The toolholder uses a 3/16 inch square tool bit. The bit is held in place with setscrews. As you can see, the butt (end opposite the nose or tip) of the tool bit is lower than its cutting tip, and the tool bit is rotated counterclockwise looking from the butt end.

The side rake and back rake angles are both 14.43°. (This derives from a symmetric rake plane that is inclined 20° to the horizontal.) 14.43 is not a magic number, but it is a good compromise for cutting various steel and aluminum alloys. If you are dealing with particularly hard steel, you can reduce the spindle speed. The toolholder is also very effective for plastic, wood and other materials, but would not be appropriate for something like brass that calls for a zero or negative rake angle.

Viewed from above, the tool bit is oriented only 20° from the (rotational) axis of the lathe as is shown in the top view. This means that this toolholder is not very useful in profiling complex contours or in facing the end of a piece that is held by a center. Fortunately, most lathe work is not of that sort. For ordinary turning and facing, this tool works beautifully.

TOOL BIT GEOMETRY

We will next demonstrate two tool bit configurations, one with negative rake that can produce a square shoulder, and one with positive rake. Tool bits of each configuration can both turn and face without being reoriented. Of course a myriad of additional bit geometries can be produced by simply varying the clearance and lead angles of the bit.

Let's start with the negative rake tool bit geometry demonstrated in Figure 3.

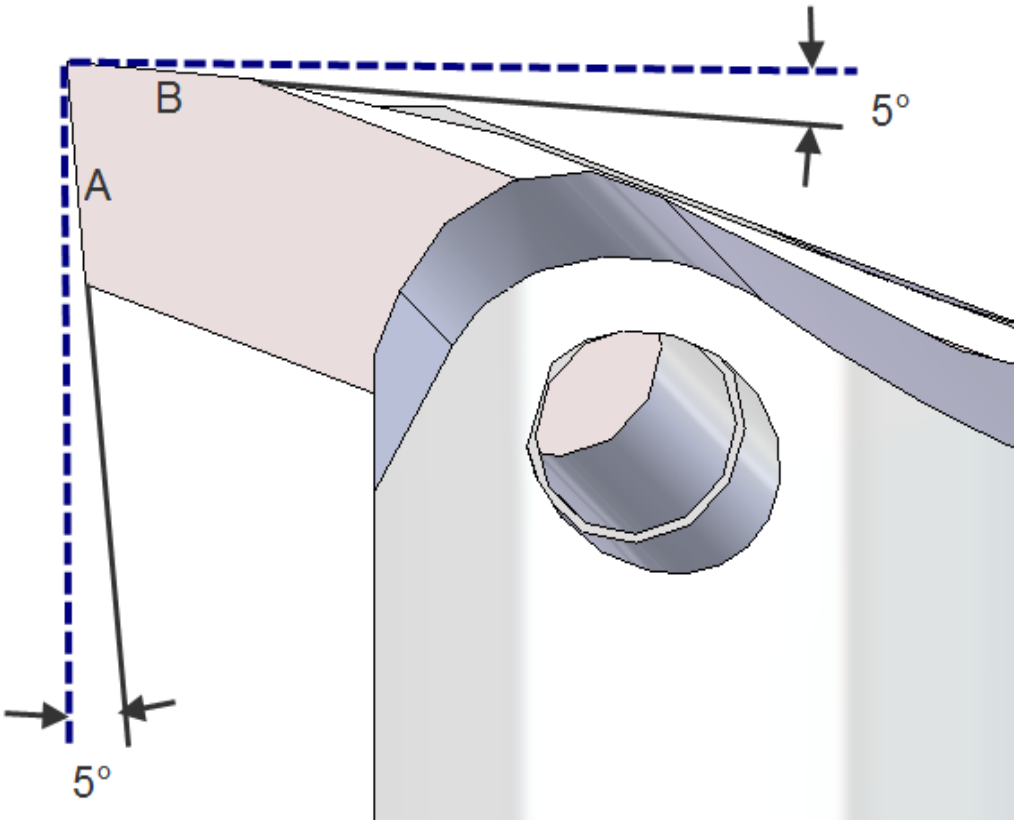


Figure 3

When turning, edge A is the cutting edge and has a negative 5° lead angle, whereas edge B has a 5° clearance angle. Similarly, when facing, edge B is the cutting edge and has a negative 5° lead angle, and edge A has a 5° clearance angle. This geometry allows the bit to produce a square shoulder, and of course to turn and face in the same orientation. (The bit can also produce a radiused end on the workpiece when two hand wheels are manipulated at once. The ability to turn and face is similar to that of an 80° diamond-shaped carbide insert with at -5° side cutting edge angle.

Because the tool bit is oriented only 20 degrees from the axis of the lathe, the facet that contains edge B is longer and of greater surface area and therefore harder to grind than the facet that contains edge A. It is therefore recommended that cutting edge B be only a little longer than the deepest facing cut anticipated.

You may want to use the -5° lead angle bit for general-purpose work. You should understand, however, that the negative lead angles, especially combined with high rake angles and a great depth of cut, tend to pull the tool bit into the work, either by dislodging the tool bit, or using the play in the lead screw to move the cross slide. Therefore, care must be exercised using this geometry, especially when attempting aggressive cuts in an older or loose lathe.

Now let's turn to the positive lead configuration shown in Figure 4.

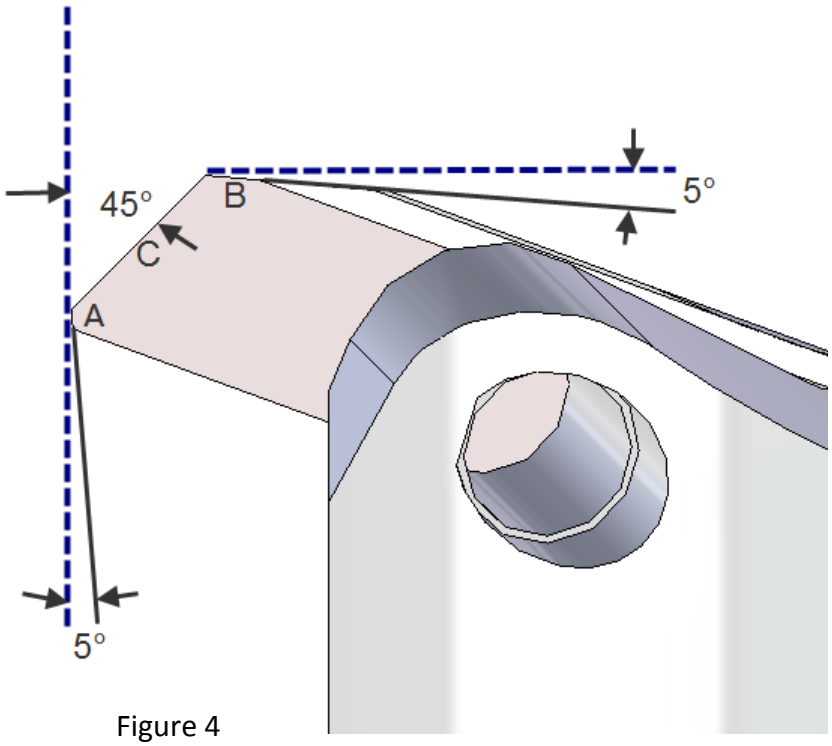


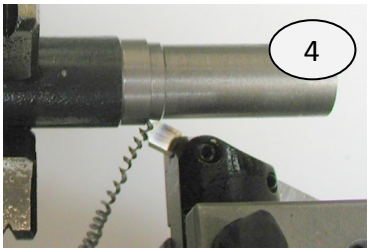
Figure 4

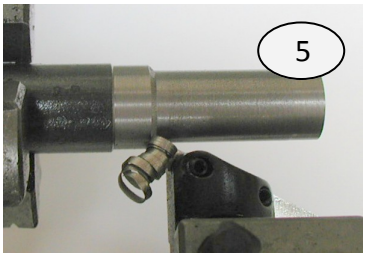
This is a highly unorthodox geometry that incorporates two tool bit noses, allowing this bit to both turn and face (but not turn to a shoulder). Because the back rake is equal to the side rake, a lead angle of 45° creates a horizontal cutting edge. Therefore, if we have noses on either end of this cutting edge they will be at the same height, and adjusting the tool bit for the height of the left or facing nose will take care of the right or turning nose as well.

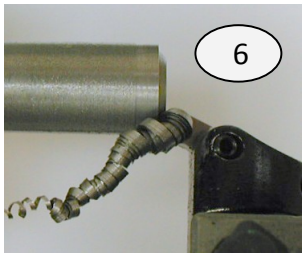
A bit ground in this manner does not tend to get pulled into the work. Further, a positive lead is more efficient because, for a given depth of cut a greater length of the cutting edge is employed which results in a thinner chip. Therefore, a substantially deeper cut can be taken.

The letters A, B, and C are the three edges that must be created in grinding this bit configuration. Edge C is the cutting edge, and edges A and B, contiguous with edge C and on either side of it, are associated with clearance angles. Compare edges A and B. to those in the previous figure relating to negative lead angle geometry. They are oriented precisely the same, but are much shorter. As previously stated, each of these edges is characterized by a clearance angle and does not cut. It is desirable to keep these edges quite short so that they do not needlessly reduce the length of the only cutting edge, C. Cutting edge C has a lead angle of 45° both for turning and facing. This configuration limits the depth of cut to about .120", which should be entirely adequate. It also allows for chamfers of up to about .170" long. (Longer chamfers can be made in multiple steps.)

TOOLHOLDER IN USE







The operations as shown in photographs 4 through 6 are described in Table 1. The stock is hot rolled steel.

Table 1

Photo-graph	Lead Angle in degrees	Type of cut	Spindle Speed in RPM	Depth of Cut in inches	Feed Rate in inches/rev.	Diameter of Stock
4	-5	Turning	410	0.030	0.0062	0.710
5	45	Turning	410	0.050	0.0062	0.710
6	45	Facing	410	0.050	0.0042	0.610

HOW IT WORKS

The principal virtue of the Wimberley toolholder is that the tool bit can be sharpened very easily. Built in side rake and back rake angles are equal. Similarly, I recommend that the side and end relief angles both be 8° for general-purpose work (greater relief angles may be employed for softer materials, but are not necessary).

Two or three facets, represented by edges A, B, and C from the previous figures must be ground.

Traditionally, a radius is added to the nose of the tool. In practice, one to three intermediate facets can replace the radius on the negative lead angle tool bit whereas simply stoning the nose suffices for the positive rake tool.

This toolholder really shines when it is used in conjunction with quick change tool posts such as the Aloris, or Multifix, or their clones. No special fixture is required for sharpening; the tool block that is part of the Aloris or similar system holds the toolholder which, in turn, holds the tool bit. (The term **tool block** is used instead of toolholder to reduce confusion.)

The sharpening process is very similar to that used in creating the flanks of a conventional single point cutting tool. To sharpen the bit, loosen the set screws and slide the bit along its axis so that the tip is about three quarters of an inch from the left surface of the toolholder. The tool block is placed on the table of an appropriate grinder adjusted so as to provide 8° of relief (the angle between the grinding surface and the table is 98°). The facets can be ground by eye or with the aid of marks on the table or other means to establish the lead and clearance angles. The same inclination of the table is used to create the nose radii (or facets).

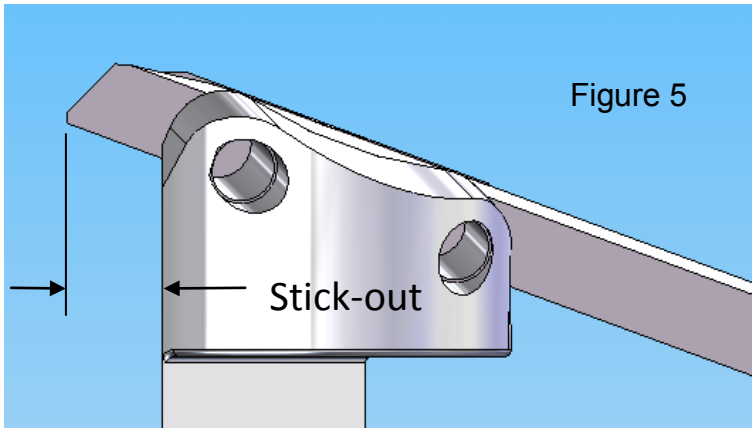
Generally the wear will be on the flanks of the tool. Therefore only enough material needs to be removed to clean up this wear, and very little material is removed in the sharpening process. A high speed steel tool bit will last a very long time. Grinding the flanks of a tool bit in the Wimberley toolholder is good practice for grinding a conventional tool bit, and thus gives the user an introduction to conventional tool bit grinding while eliminating the somewhat daunting and wasteful task of grinding the rake face.

After grinding the flanks and nose radius or radii, the tool needs only to be honed before it is used.

As stated, there is no need to create a rake face; any one of the long sides (factory prepared) of the bit conveniently serves as the rake face. The sides of the bit tend to be very smooth and are sometimes even polished. Furthermore, because the entire side of the tool bit serves as the rake face, it is easy to make that surface very smooth with some 280 (or finer) grit silicon carbide paper on a flat substrate or with a fine hand stone. It is very difficult to get an equivalent degree of rake-face smoothness in a conventionally ground tool bit.

The coarse wheel on an ordinary bench grinder can also be effectively used for roughing out the tool bit, provided the wheel is occasionally dressed with a star wheel dresser.

In addition to simplifying bit sharpening, this toolholder makes it very easy to reestablish the tool height after the tool has been sharpened. The tip of the tool is specified as 15/64" to the left of the leftmost surface of the toolholder. This distance, which we call the stick-out is shown in figure 5.



The stick-out is established as follows. A surface perpendicular to the axis of the lathe must be available. This could either be the end of the chuck or the faced end of a workpiece. With a 15/64"drill bit or transfer punch in one's left hand, the left edge of the toolholder is brought close to the perpendicular surface. The butt of the drill bit is interposed between the toolholder and the surface, and the lathe's carriage moved to the left until the drill bit is trapped. The carriage is locked if need be. The cross slide is then backed out allowing the drill bit to rotate until it is no longer trapped between the toolholder and the perpendicular surface. At this point, the distance between the toolholder and the perpendicular surface has been established. The freshly sharpened bit is then inserted into the toolholder and, while completely seated in the groove of the toolholder, is slid axially until the tip touches the perpendicular surface. At that point, the proper stick-out is established and the set screws can be tightened. When the stick-out is correct, the height of the tool bit is also correct so there is no need to reestablish the height of the tool bit.

It is important to note that the tip of the tool bit will be almost precisely level with the top of the 1/2 inch shank for the negative lead angle tool bit. The tip will be about .041" lower for the positive lead angle tool bit. Therefore, if you are using a single toolholder, and swapping between these two bit geometries, you will need to adjust the height of the tool holder with the Aloris tool block or its equivalent.

(Alternately you could use different stick-out for the two tools, .234” for the positive lead angle tool, and about .125” to .145” for the negative lead angle tool, depending on nose radius.)

The cutting tip of the tool bit is the leftmost portion of the tool post assembly. This is convenient for two reasons. First, the tip of the tool is easily visible, especially if the lathe is high or the operator is not so high. Having the tool tip to the left of the toolholder also reduces the likelihood that some other portion of the lathe will strike the chuck prior to the tip.

If you have a single toolholder, you can just swap bits to obtain the two described tool tip geometries. If you have two toolholders, you can dedicate a toolholder and tool block for each of these two geometries. Of course a vast array of other lead angles can be experimented with, but the two geometries herein presented should take care of nearly all of your turning and facing needs.

TOOLS AND TECHNIQUES FOR SHARPENING THE BIT

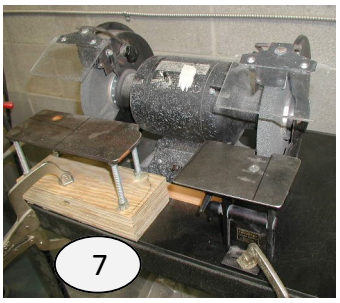
Types of Grinders

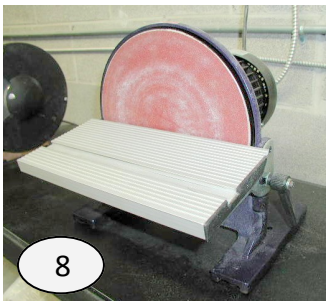
The bit can be roughed out on the coarse wheel of a bench grinder, on the contact wheel of a belt grinder or on the platen of a belt grinder.

I do not recommend belt grinders for finish grinding because it isn't possible to create a crisp facet, given that the belt is not firmly attached to the platen or substrate. Similarly, a disk sander whose sanding disc is not stuck to the substrate everywhere will not create a clean facet.

When grinding, the bit should be moved back and forth across the abrasive surface to even the wear on the abrasive surface.

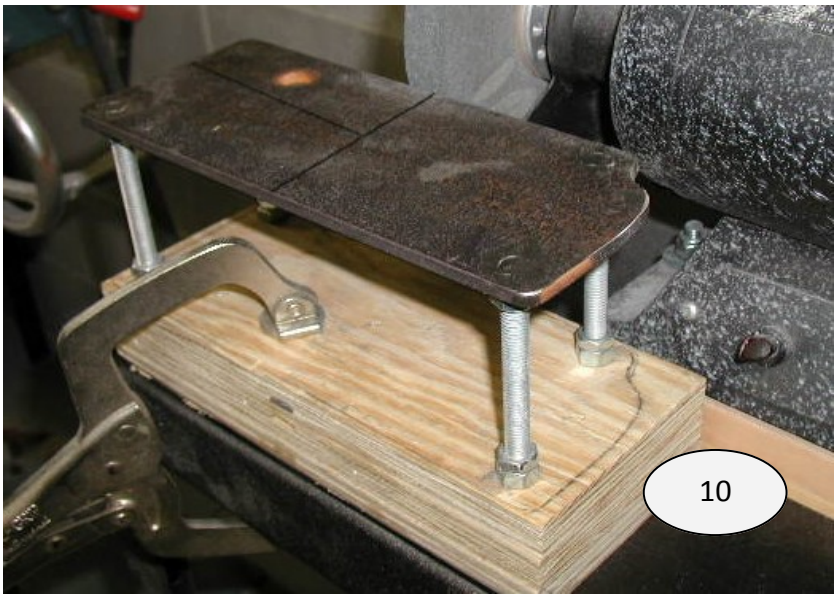
A great variety of tools could be used to grind a tool bit, but the most commonly available candidates are the bench grinder (photograph 7), the disk sander (photograph 8), and the so-called carbide grinder (photograph 9) with an aluminum oxide wheel to replace the original silicon carbide wheel.





The least expensive option, and the tool that most people will already have, is the bench grinder. The problem with a bench grinder is that the work support table will almost certainly be too small. You have two options. One is to purchase an aftermarket table, but even the aftermarket table will probably be too small. You will need to fasten a thin table of larger area to the existing aftermarket table. The second option is to fashion a horizontal table in front of the wheel. The top of the table must be located at such a height that that the tip of the tool will be 8° (or whatever relief angle you have selected) above the axis of the wheel.

Using the Bench Grinder and Horizontal Table



We will first describe how to Sharpen a tool bit using a horizontal table such as that shown in photograph 7 and a little closer in photograph 10. Let's start by showing how a horizontal table is made and positioned vertically relative to the wheel.

In preparing for the DVD, I made the table shown in photograph 10. I used plywood for the base of this portable table, but given the fact that you will be producing hot sparks, I recommend that the table be made entirely of metal or other noncombustible material.

The table is made of a piece of quarter inch or so steel or aluminum, four 3/8 inch threaded rods and 3 nuts per rod (more if you use jam nuts). Four holes are drilled in the bench upon which the grinder is mounted. The holes in the tabletop are threaded.

The threaded rods make the table Adjustable in height. (The height of the table will have to be adjusted from time to time to compensate for wear of the wheel.) For clarity the surface upon which the grinder is mounted is called the **bench**, and the surface upon which the tool block rests is called the **table**.

The height of the table (The distance between the top of the table and the top of the bench)=

- the distance from the top of the bench to the center of the wheel

- plus the distance between the center of the wheel and the tip of the tool (sin(8°) X diameter wheel/ 2
  [sin(8°) is approximately 0.139]

- minus the distance between the tip of the tool and the bottom of the tool block

For example if the Distance from the top of the bench to the center of the wheel is 7 inches, the diameter of the wheel is 7.75 inches, and the distance between the tip of the tool and the top of the table is 0.9 inches, then the distance between the top of the table and the top of the bench should be 7 + (.139 X 7.75/2) - .09 = 6.339 inches.

Figure 6 Is a schematic that shows an adjustable horizontal table In front of a bench grinder. A tool block holds a tool bit that contacts the wheel creating 8° of relief.

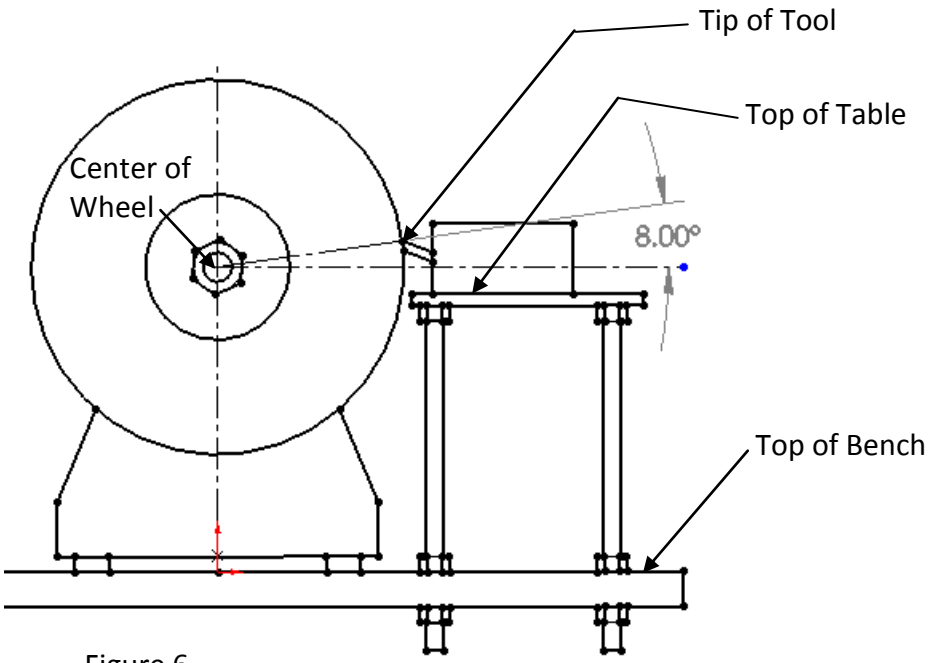
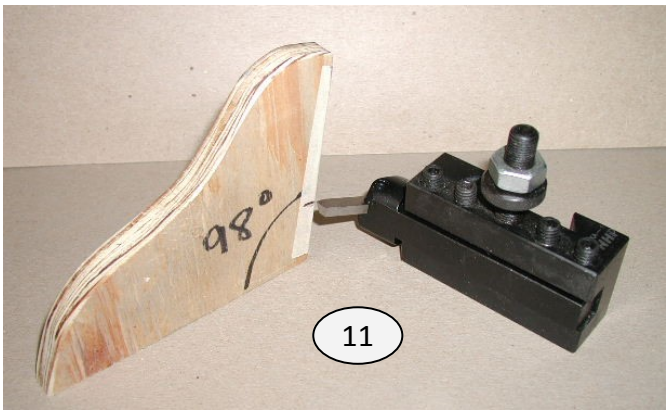


Figure 6

It should only be necessary to construct a horizontal table for the fine wheel; the tool can be roughed out on the coarse wheel without the benefit of such precision.

After completion, the height of the table is checked using an angle block as shown in Photographs 11 and 12. In photograph 11 a mark has been created on the edge of the plywood angle block at the height of the tip of the tool bit. In photograph12, you can see that the table height is set correctly because the edge of the plywood angle block is tangent to the wheel at the height of the tip of the tool bit.



11

The angle block is made from a plywood scrap. A machinist's square and steel angle blocks of 5° and 3° to create the 98°angle. Masking tape over the edge allows you to Mark the square without marring it. You can use figure 8 on the last page as a "quick and dirty" means of creating an angle block.

12

Determining How Much Stick-Out to Use in Grinding

In photograph 11 you'll notice that the tool bit sticks out quite a bit more than it would when it is set up in the lathe. For a variety of reasons, it is necessary to increase the tool stick-out for the sharpening process. I recommend that you start with a stick out of 3/4"; beginners should probably just stick with this figure and ignore the more complicated issues discussed below.

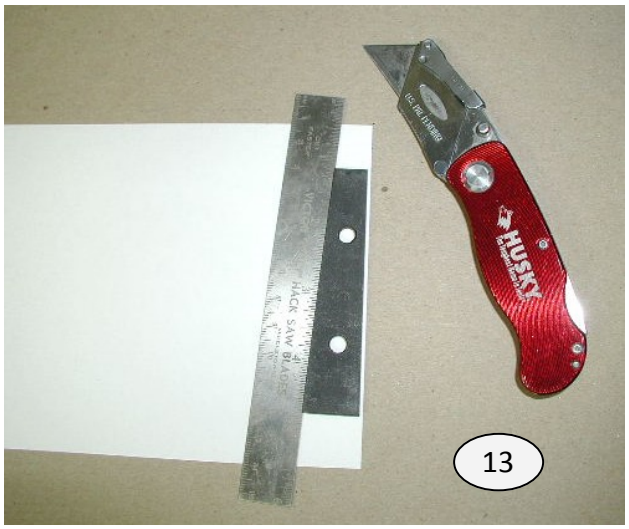
The stick-out of the tool bit during grinding accomplishes two things. First, it provides clearance for the toolholder so you don't inadvertently grind the lower portion of the toolholder. Second, it elevates the butt of the tool bit so that it does not extend beyond the lower surface of the tool block. Obviously, this is less of an issue or if you are using a shorter tool bit, but if you are using a new tool bit, and want to use a small stick-out dimension, you may have to put a spacer under the tool block to elevate it and provide clearance for the butt of the tool bit.

Once you are familiar with the process you may choose to experiment with a shorter stick-out, for example if the tool bit is short, but this will require adjusting the height of the horizontal table. (smaller stick-out would not require adjustment of a tilting table on a tool such as a disk sander or carbide grinder where the grinding surface is planar as opposed to the cylindrical surface of the wheel of the bench grinder.)

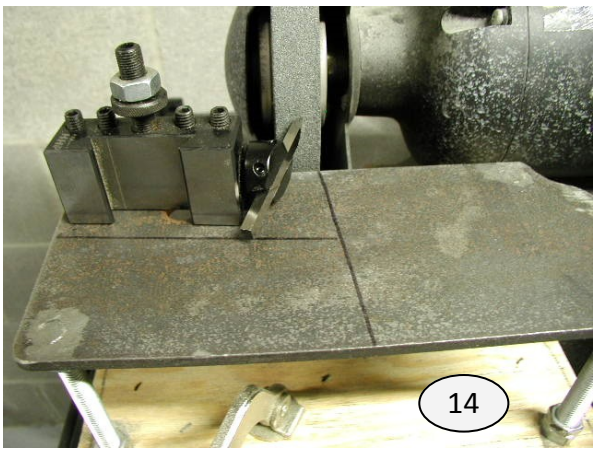
As an aside, I might mention that the geometry of a bench grinder, as opposed to a disk sander, allows you to use less stick-out. With a bench grinder you can probably get by with as little as .450" stick-out, but grinding will be easier if the stick-out is ¾". Using less stick-out allows for more parsimonious use of your tool bit but you may have to grind into the side of the tool bit slightly and may not be able to use the entire face of the grinding wheel. It is possible you may grind a little off the lower portion of the toolholder while experimenting with stick-out and possibly relief angle. This shouldn't be anything to worry about.

Getting the Angles Right

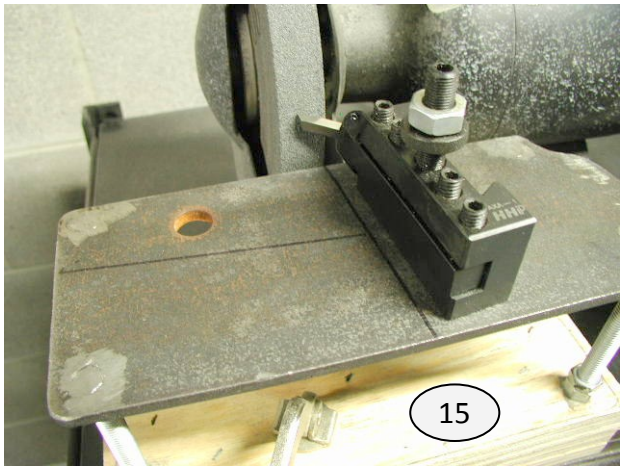
Grinding the tool bit by eye is not difficult, but guidelines are easy to create and helpful. I have made some fixtures for use with the carbide grinder, but this is entirely unnecessary. In the photographs below you will see guidelines drawn on the grinder tables.



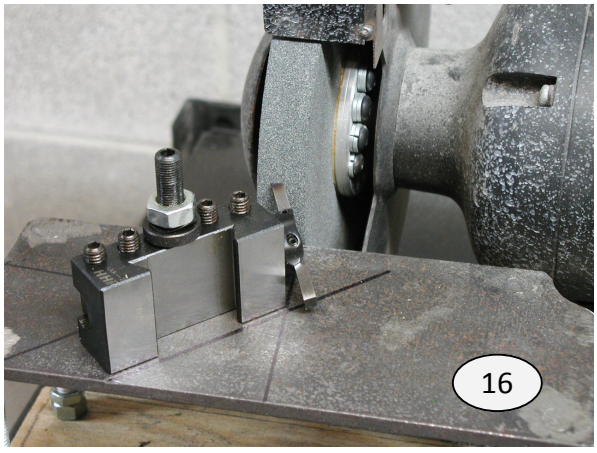
Drawing guidelines on tool support tables is facilitated by using index cards trimmed to the relevant angles. These can easily be created with a scale, an angle block, and a utility knife, as shown in photograph 13.



Photograph 14 shows a guideline facilitating the grinding of the facet associated with edge A In figures 3 and 4. The guideline being used is 5° *clockwise* of parallel to the face of the wheel.



Photograph 15 shows a guideline facilitating the grinding of the facet associated with edge B In figures 3 and 4. The guideline being used is 5° *counterclockwise* of perpendicular to the face of the wheel. (The angle between the two guidelines shown is 100°.)



Photograph 16 shows a guideline facilitating the grinding of the facet associated with edge C In figure 4 and the first facet involved in creating the nose of the tool bit in Figure 3 (discussed below). The guideline being used is 45° counterclockwise of parallel to the face of the wheel.

In following the guidelines, it is good practice whenever possible to move the work back and forth across the face of the wheel so that wear occurs evenly as you grind.

Refining the Nose or Noses of the Tool Bit

Lathe tool bits generally incorporate a radiused nose. Refer to the bit in figure 4. This is the tool with two noses and a lead angle of 45°. The angles between the edges A and C, and edges C and B are about 130°. The corner created by the intersection of the two flanks associated with these noses can simply be lightly stoned. The obtuse 130° angle eliminates the need for any substantial refinement.

Now refer to figure 3. This tool has a single nose and a lead angle of -5°. The first step in defining the nose of this tool is to, as shown in photograph 16, create a tiny facet which creates the same angles mentioned above. Such a facet is shown on the left of Figure 7. Once this facet has been created, one option is to simply stone the corners as described above. If you want to more closely approximate a radius, you can produce two intermediate facets as shown to the right in figure 7. At this point, four corners have been produced which can then be stoned.

I generally use a very small radius, on the order of 1/64", which means the length of the edge produced with the first cut in figure 7 would be about .015". This radius is just large enough to protect the point of the tool. Of course you can create a larger radius if you wish to. Because of the mass of the tool block and the friction of the tool block on the grinding table, it is difficult to

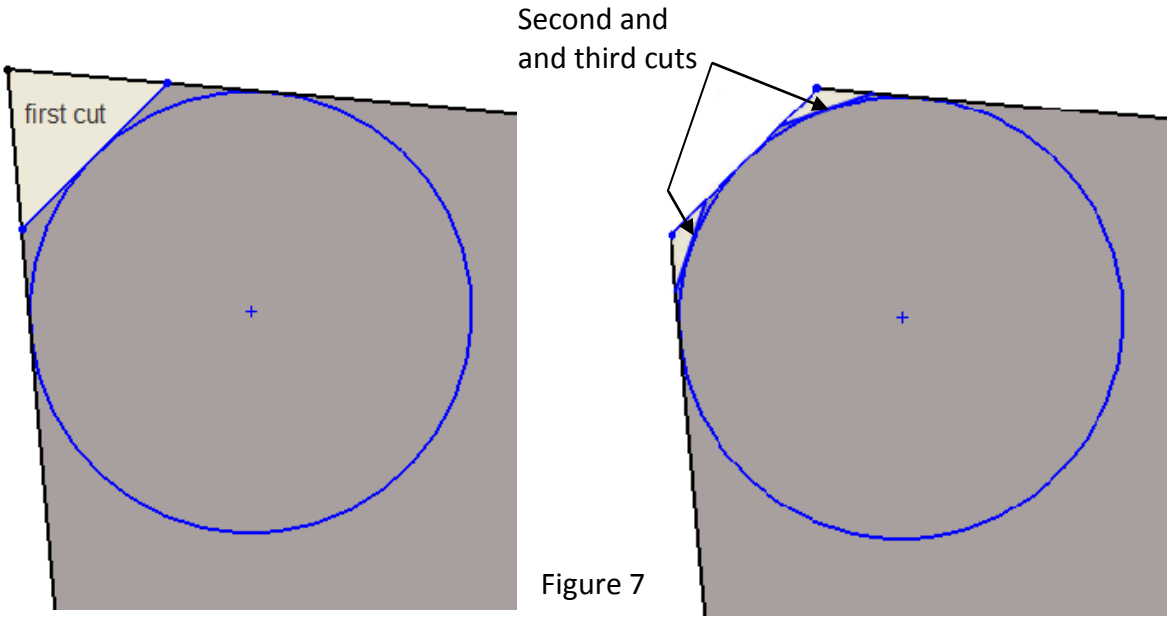


Figure 7

produce a radius in one sweeping motion as one might do with a loose tool bit. Therefore I prefer the faceted approach discussed above. Very little material is removed in this process. Therefore I turn the grinder off, and while it is coasting, grind the facets. The first facet will involve removing the most material. You could draw intermediate guidelines on the table to create the second and third cuts in figure 7, but this is really not necessary.

Of course the inclination of the table remains the same throughout. (It is common, but incorrect, practice to change the angle of the table when grinding a radius or flat at the tip of the tool, but it is contrary to the description in Machinery's Handbook, and it is obvious that commercial carbide inserts are not made this way.) If your "radius" is small, you may notice that it does not extend all the way down to the bottom surface of the bit opposite the rake surface. This is normal and to be expected. It is, however, something that you have to keep in mind when you are honing the bit.

Honing the Bit

Honing the bit is simple. It is also probably unnecessary, given the fact that many experts skip this step. On the other hand, it does give you the satisfaction of creating what seems like a near perfect edge. I have found that the best stone for honing the bit is a fine 1/4 inch square cross-section aluminum oxide stone. An ordinary fine pocket stone or other small hand stone with a flat working surface should work fine. I find it useful to wear Optivisors ® or other magnifying glasses while honing the bit.

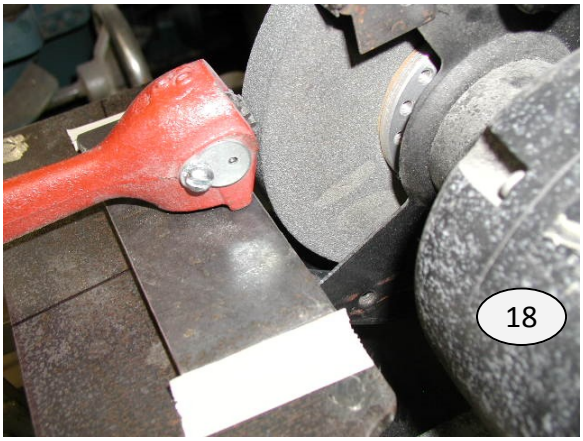
Photograph 17 show the bit being honed. If you are right handed, hold the stone in your right hand and the bit in your left hand, rake face up. Start with the closest flank which will be the end flank. Adjust the surface of the stone and the flank of the bit until they are completely coincident, with the stone extending beyond the bit above and below. Gently hone the bit by moving the hone parallel to the end cutting edge. Work your way around the radius to the side flank, paying special attention to stay on the ground facets if your nose radius facets do not extend all the way to the bottom of the bit.

Resharpening

If you are resharpening a bit, very little material will have to be removed. In contrast to the original sharpening, however, there will generally be some build up on the tool from previous usage. The first step will be to remove that build up, either with a hard abrasive hand stone, or with some 280 (or so) grit silicon carbide paper on a flat substrate such as the table of a milling machine. (Make sure there are no particles between the abrasive paper and the substrate.)

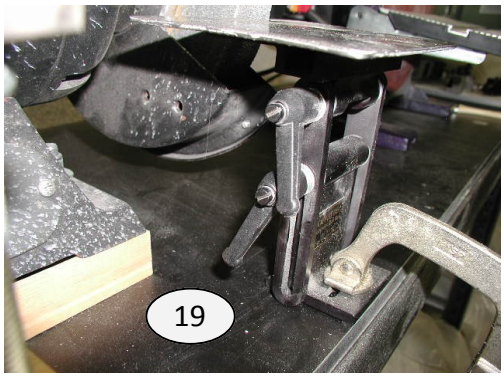
Once the rake face has been cleaned with a stone or abrasive paper, resharpening a bit is simply a matter of touching up the flanks and nose radius or radii, if any, and honing. As previously stated, very little material will need to be removed unless the bit has been abused, and for example, a crater has been produced on the rake face.

Dressing the Grinding Wheel

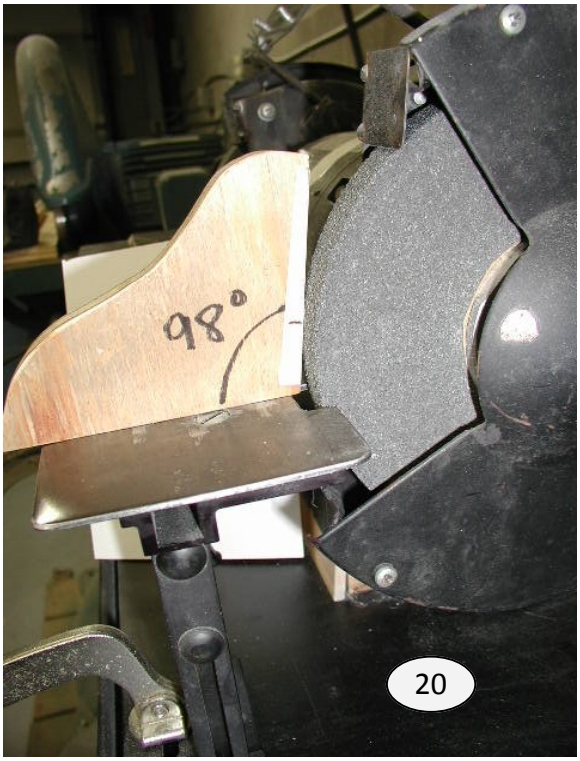


The aluminum oxide wheels that typically come with a bench grinder are much more efficient cutting instruments if they are occasionally dressed with a star wheel dresser such as that shown in photograph 18. A 3/8 inch thick plate has been taped to the tabletop to ensure that the center of the star wheel is above the center of the grinding wheel. See http://www.kut-rite.com/dressers.php for instructions on how to use the star wheel dresser.

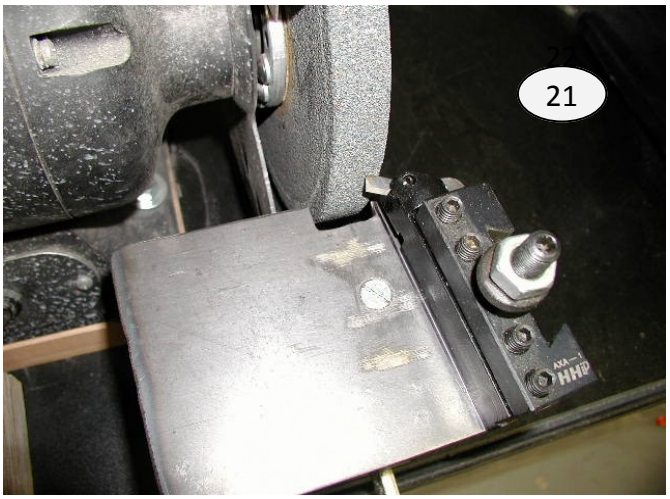
Using the Bench Grinder with Tilting Table



Photograph 19 shows an aftermarket table, the Veritas® grinder tool rest sold by Lee Valley, with a steel table, .100” thick added.



Photograph 20 demonstrates how the angle of the work table must be adjusted using the previously shown shop-made angle block. The wheel must be tangent to the edge of the angle block at the height of the tool bit tip above the table. (See also the earlier discussion.)

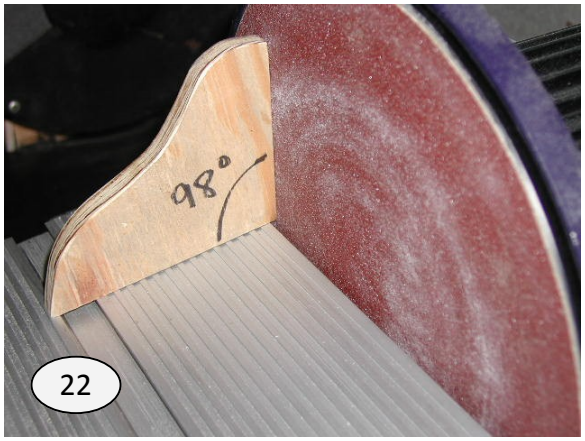


In Photograph 20, the end flank (The facet that includes edge B in figures 3 and four) is being ground on the bench grinder using the Veritas® adjustable table with steel plate attached. Note that a much smaller stick-out dimension Is being used for this demonstration. (Keep in mind that reducing the stick-out reduces the height of the tool tip and will therefore lowers the mark on the angle block used in photograph 20 to adjust the table angle.)

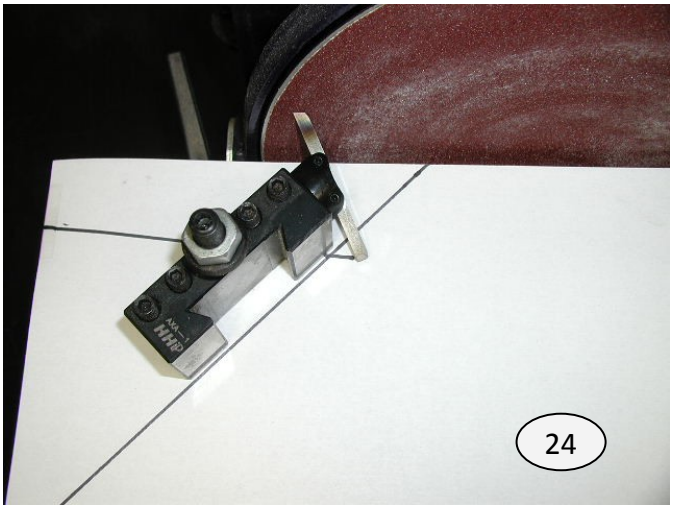
Using the Disk Sander

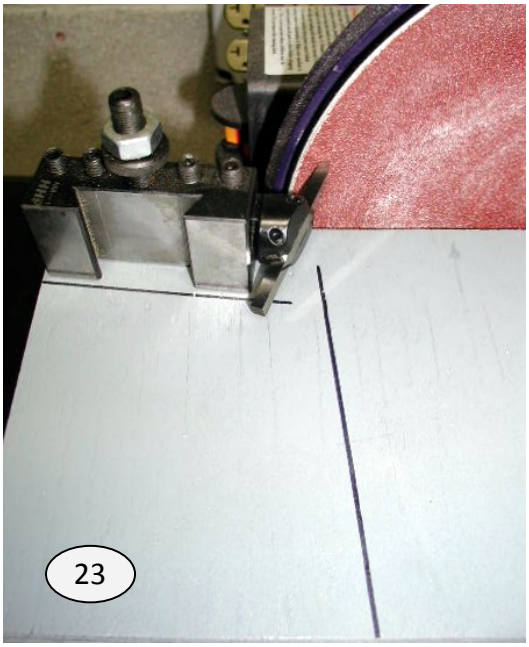
The next option is a disk sander. It would be nice to have a sander that is reasonably good-sized although a small disk sander of sufficient rigidity would work. I selected a nominally 10 inch disk sander from Harbor Freight for demonstration. It is actually a 25 cm sander.

I had this shipped to me and it was treated pretty roughly in transit. I spent quite a while adjusting the disc with a hammer and dial indicator to get it to run true. (Prying out the low portion was not successful.) In addition, and I removed and straightened the brackets under the table, removed the plastic dust guard, given the fact that the tool would be used for grinding rather than sanding. The locking levers were the type that allows adjustment of the position of the lever. I disabled that function with epoxy. Having done all those things, the table on the sander is surprisingly easy to adjust.



In photograph 22 an angle block is being used to set the angle of the work table on the Harbor Freight 10 inch disk sander.

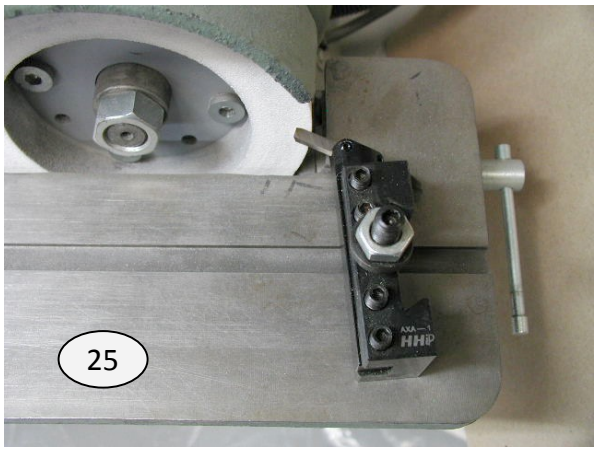




In photographs 23 and 24 the disk sander (rotation counterclockwise) has been fitted with table extenders upon which guidelines are drawn. In photograph 23 the left flank, or the facet that contains edge A in figures 3 and 4 is being ground. In photograph 24 the facet that includes the cutting-edge (C) in figure 4 is being ground. The table extenders make sharpening a tool bit much easier. This extender has a tongue that rides in the miter slot thus avoiding the need for fasteners.

Using the Carbide Grinder

The final option I will discuss, the most expensive, is the so-called carbide grinder. These grinders come with two silicon carbide wheels. These wheels are not suitable for grinding high speed steel. I replaced one of the wheels with an aluminum oxide wheel I bought from MSC about $80. The grinder currently (spring of 2010) sells for $160 at Harbor Freight. I got mine on sale for $120, and you may be able to find a bargain. I would not pay a lot more than the harbor freight price for a Chinese carbide grinder because it's not likely to be much different from the harbor freight version. Of course you can buy beautiful used American-made grinders by various manufacturers on eBay, but they are expensive. A new Baldor version of this grinder can be had for more than $900. For my limited use, the harbor freight model is quite adequate.

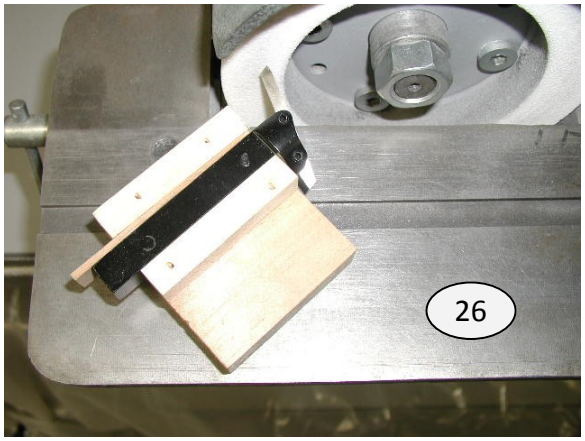


Photograph 25 demonstrates grinding the end flank (The facet that includes edge B in figures 3 and four) on the right-hand side of the carbide grinder. I usually use the left side of the wheel. The tool block is oriented about 5° counterclockwise from perpendicular to the face of the wheel without using a guideline.

Using an Wooden Sled

You can set the table inclination with the angle block. I leave mine set at 8°. Unfortunately the table is not very easy to adjust. One of advantages of a carbide grinder is that it has a slot in the table and a miter gauge. The slot makes it possible to fashion a diamond dresser that rides in the slot so you can true the wheel. After the wheel is true, you can rough it up with a Norbide (boron carbide) stick. I'm not very experienced with these sticks, but I run a corner of the stick across the wheel and it does make the wheel cut more aggressively. Until the wheel has worn down a bit after dressing with Norbide it grinds a little coarsely.

The carbide grinder is quite versatile. I do most of my grinding on the left side of the wheel, but the rotation the wheel can be reversed allowing for grinding on the right-hand side of the wheel. (The direction of the grinding surface must be downward relative to the bit being ground.)



A simple wooden sled for holding the toolholder is shown in photograph 26. Is generally most convenient to sharpen the tool bit with the toolholder held in a quick release tool block. A wooden sled, however, can be substituted and may make it somewhat easier to grind a radius on the nose because the sled is much lighter than a tool block. The toolholder is held in place with a wedge-shaped carpenter's shim.

Grinding High Speed Steel

Many people have followed the well-meaning advice to never grind high speed steel hot enough to create oxidation colors. I am indebted to Ed Huntress, whose posts on rec.crafts.metalworking set me straight. Ed advocates for a return to the way things were done in ordinary machine shops in the heyday of high speed steel tooling.

One of the cardinal characteristics of high speed steel is its ability to withstand the high temperatures that are generated by machining at high speed, hence the name. The minimum tempering temperature for high speed steels is about 1000°F. Therefore, you can grind until the bit has achieved a dull red next to the grinding wheel. Oxidation colors are certainly no problem. Not only is there no need to quench the tool, but you can damage the cutting-edge by generating small fractures if you quench the tool occasionally; high speed steel should be ground dry in the home shop setting.

Here's what Ed said about applying pressure to the tool bit. “If you can handle it you aren't applying enough pressure to grind it efficiently. HSS requires some pressure, which is hell on grinding wheels but it beats taking an hour to grind a threading bit from a blank. I hold HSS bits with Vise-Grip pliers when I'm grinding them. Sometimes I clamp them in a toolholder and hang onto that.” Google “Ed Huntress grinding high speed steel” for more of his useful observations. By the way, grinding high speed steel may be “hell on grinding wheels”, but even an inexpensive grinding wheel will last a very long time in the hands of a moderately careful amateur machinist.

CUTTING PARAMETERS

Routine cuts in hot rolled steel are shown in the table 2.

Table 2

Lead Angle in degrees	Surface Feet Per Minute	Depth of Cut in inches	Feed Rate in inches/ rev.
-5	80	0.030	0.0062
45	80	0.050	0.0062

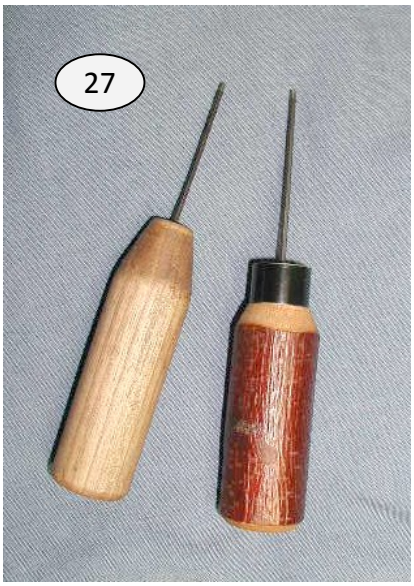
The surface feet per minute can be adjusted according to material. It can be increased for free machining steel, and can be tripled for aluminum. The surface feet per minute should be dramatically reduced for hard materials. Machinery's handbook is a good source of information in this regard.

The above parameters result in respectable rates of removal of material without overly stressing the tool bit. Furthermore, a surface feet per minute rate of 80 ft./m or less minimizes chip welding on the rake surface of the tool bit. All of this assumes that the bit is adequately lubricated with cutting oil. Pushing the tool bit, the toolholder, and the lathe excessively, as you should know, is dangerous, and completely unnecessary in a home shop environment. Pushing the negative lead angle bit can cause the tool to be pulled from the holder or cause the carriage to be pulled toward the work resulting in inaccurate cuts or worse.

MAKING A HEX DRIVER

Photograph 27 shows two handy hex drivers that make working with your Wimberley toolholder more enjoyable. To make a driver like these, heat the bend of a long (not short) hex key to red heat and straighten it on an anvil or the equivalent. Cool the hex key and clean the oxide layer from the straightened half of the key with sandpaper . Chamfer the straightened end of the hex key lightly with a grinder. Clean the hex key with alcohol or detergent and water, and set aside. Turn a handle to a convenient size and shape. (The driver on the left, made of walnut, is 1.1 inches in diameter and 3.5 inches long.)

The drill bit should be the size of the hex key across the corners, in the case of a 2.5 mm hex key, .086 inches, or a number 44 drill bit. Drill the hole for the hex key in the handle to a depth of one half of the length of the straightened hex key. Countersink the end of the handle to facilitate the application of epoxy if you wish.



Hold the handle, hole side up, in a vise between soft jaws. Mix up a generous batch of epoxy. Using a discarded kitchen knife, force epoxy into the hole. Use a small wire to ram epoxy into the hole and coat the inside of the hole to its full depth. You will be driving the hex key into this hole. If you drive it too far you may split the handle. Therefore, place a piece of masking tape on the undisturbed half of the hex key about a quarter of an inch away from the center of the hex key as a reference. Coat the straightened half of the hex key with epoxy. Drive the straightened end of the hex key into the hole until half of the key is in the handle. Wipe off any extra. Clean up with denatured or isopropyl alcohol. Allow the epoxy to cure.

In use, you will notice that the tool winds up slightly as you tighten a set screw. The tool seems entirely capable of exerting adequate torque on the set screw.

If you wish to install a ferrule, you may want to do it after the hex key has been installed. There should be an interference fit of about .004” between the handle and the ferrule. The back side of the ferrule is chamfered on the inside to facilitate installation

ALTERNATIVES TO THE WIMBERLEY TOOLHOLDER

I sometimes think that this would have been a great invention to introduce in the 1920s. Of course, most American machine shops were probably using lantern type tool posts that would not allow the user to take full advantage of this device. These days almost all production machining is done with indexable carbide tools or the like.

This begs the question -- why not just use indexable carbide tools? Undoubtedly, if you have the time, the money, and the patience, you can round up a set of carbide tools that will do most of what you want them to. If you wanted to go this route, I think your best bet would be to find a top-notch sales representative and have him outfit you. This would, undoubtedly, be expensive, and he would recommend different inserts for different materials. Furthermore, you may find that your lathe does not have the rigidity or spindle speed to make full use of carbide tooling. In addition, a lot of carbide tooling has a so-called honed edge which means that the edge is not very sharp. It is very tempting to buy an inexpensive set of carbide toolholders; I have certainly done so. The carbide inserts that come with these toolholders tend to have “honed edges” and are therefore not sharp. The finish you get tends to have a smeared non-uniform appearance with bright burnished areas that are evidence of the tool doing something other than cutting cleanly.

Things are a lot more predictable for the beginner if he has truly sharp tooling. My business neighbor runs a machine shop and virtually never uses a high speed steel tool bit, but he does pay a high price for his carbide tooling. His trusty salesman has set him up with inserts that are indeed sharp and allow him to create good surface finishes. As an amateur, however I have never been attracted to his solution because the toolholder I have developed is so versatile and easy to use. I know that a really keen edge is only a few minutes and pennies away.

You do have options other than the Wimberley toolholder, conventional high-speed steel lathe tools and conventional carbide insert toolholders (I consider braised carbide tool bits too inconvenient to sharpen). For example, Plastools makes a turn-and-face holder for triangular carbide inserts. The holder has negative rake, and relies on the carbide insert's positive rake to establish a reasonably benign working rake angle. The designer of this tool put a lot of thought into making this easy for the amateur to use. Plastools makes more than one type of toolholder, but the principal type requires that you turn with one point (that has a positive cutting-edge angle) and face with a point to the left of that. You are instructed to adjust the tool height so that the facing point is level with the axis of the lathe. In this configuration, however, the turning point is a little below center because of the negative rake of the toolholder. Specifically, the turning tip is about .014" lower than the facing tip for my version that has a half-inch shank. I am sure a lot of people would find this satisfactory but the design was not compelling enough to stop me from pursuing my own toolholder design.

A tangential holder is certainly another option. I was very curious about the specifics of the Diamond toolholder for quite a while. I imagine some users are equally curious. Therefore I've included some information about its geometry. In order to measure the rake angles, I mounted a small aluminum platform on the end of a piece of one quarter-inch key stock with JB Weld. I attached the platform so that it surface would be parallel to the plane of the ground rake face of a tool bit. (I used the sharpening fixture, 123 blocks, And double stick tape to accomplish this.)

The toolholder was designed to be operated with the shank rotated either 12° counterclockwise (looking from above) to both turn and face or 12° clockwise to turn only. The side rake and back rake figures for these configurations are shown in table 3. I used a Tilt Box ® digital inclinometer to measure the angles, being careful to obtain a proper zero before measuring the angle in question. I think my measurements are accurate to within 1/2°.

Table 3

	Shank 12° CCW (turning & facing)	Shank 12° CW (turning only)
side rake	14.85°	11.25°
back rake	5.15°	10.40°

Consider the 12° counterclockwise orientation. Whereas the 14.85° side rake and 5.15° back rake are not ideal for turning, they are less satisfactory for facing. The tool will face a piece of steel without complaint, but it is less efficient than a tool with greater back rake. The fixed side relief and end relief are both about 10°.

The relief angles are determined by the toolholder itself. The rake angles of the tool bit relative to the toolholder are determined by the sharpening fixture. The side lead angle and end lead angle are determined by the degree to which the toolholder is rotated around a vertical axis. In fact, all angles except the relief angles change when the toolholder is rotated around a vertical axis, for example to allow it to both turn and face. The nose radius is created by honing one edge of the tool bit; this does limit the user's options in this regard, although the small radius thus created is generally satisfactory.

My Toolholder is really quite different from the Diamond Toolholder. It is intended to be installed with the shank of the tool perpendicular to the axis of the lathe, and not in any other orientation Thus it is never

rotated around a vertical axis. The side and back rake angles are determined by the toolholder. The lead angles, clearance angles, and relief angles are all left to the discretion of the user, as are the nose radii. The user may choose to have two or more tool bits with very different geometries available for various purposes.

When I was using a tangential toolholder, I was very dissatisfied with flank wear. In order to clean up flank wear, you cannot grind the flank; you must grind the rake surface and quite a bit of material may need to be removed. I would be interested to know if others have had this same experience.

AUTHOR'S PREFERENCES

I use a Multifix style toolholder that allows the tool block to be positioned in 9° increments. I prefer this to the Aloris style, but I designed my toolholder with the more common Aloris system in mind. One of my tool blocks has a carbide insert-style cutoff tool which I prefer because it has built-in side clearance and back rake. Another tool block is set up to hold a half-inch shank boring bar. Additional tool blocks are handy for the occasional odd application. I have made a couple of simple tool holders that are held in the tool block. These are designed to easily and securely accommodate high-speed steel tool bits from 1/8 inch to 1/4 inch. One holder orients the tool bit conventionally (bit axis perpendicular to the axis of the lathe); the other provides about 14° of back rake. These tool bit holders might seem unnecessary, but they are surprisingly handy; it is no simple task to install a 1/8 inch tool bit in an Aloris tool block.

As a hobbyist, I do not believe in the golden chip rule. Instead of pushing things until the chips are a golden hue, I might push things until the oil starts to smoke a little and then back off. It's also a nice to keep things tame enough so that there is little or no chip welding. I find that if I keep the surface speed at about 80 ft/s or below, I can avoid chip welding when machining hot rolled steel. If you are not in a production environment, there is usually no reason to be dealing with hot aggressive chips. Furthermore, the generous rake angles provided by these tools make it easy to take off a lot of material without creating excessively hot chips. On the other hand, you can get away with higher spindle speeds than I am advocating, if you can tolerate a little smoke and chip welding.

I almost always lubricate the cutting tool. My favorite cutting oil is Accu-Lube® LB-2000. It is pretty much odor-free and does not readily smoke. It works well in all but the most demanding service. If your shop is in the basement or, as in my case, near an office environment, you probably do not want to use sulfur-bearing oil. I apply the oil very sparingly to the just-cut surface, by keeping an acid brush that has a little oil in it pressed against the surface. This technique is much more efficient than applying oil to the uncut surface.

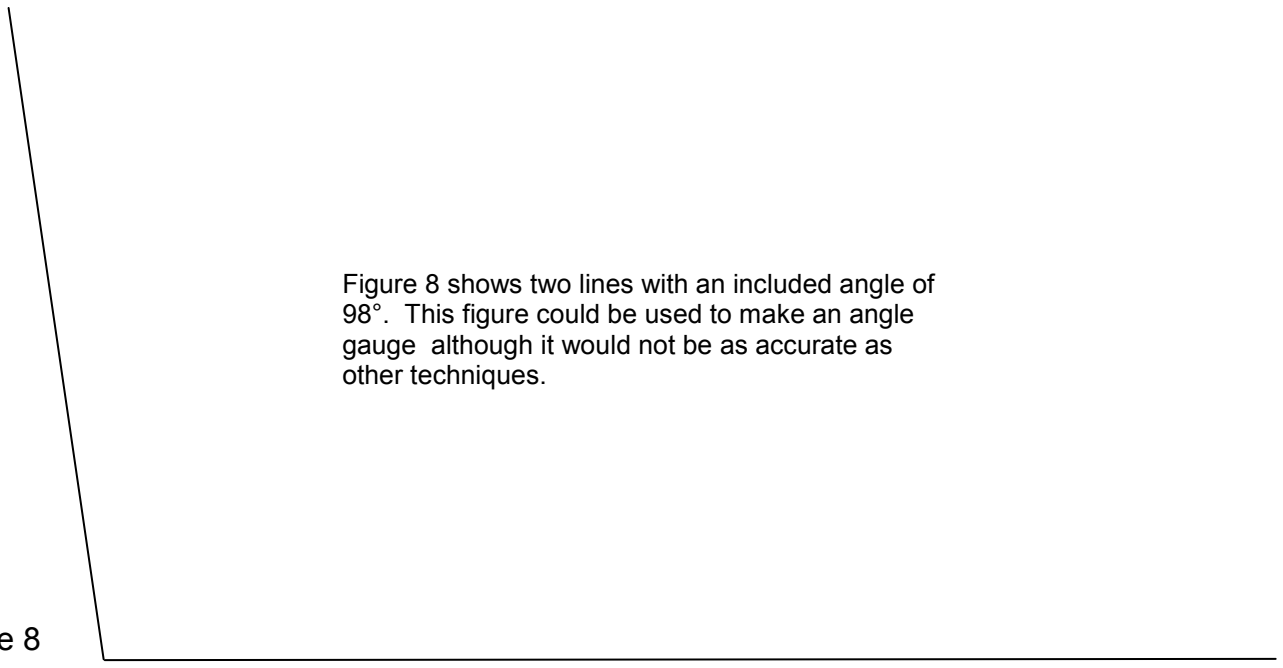


Figure 8 shows two lines with an included angle of 98°. This figure could be used to make an angle gauge although it would not be as accurate as other techniques.

Figure 8